SAE Aerospace
An SAE International Group

AEROSPACE RECOMMENDED PRACTICE

ARP4767 | REV. A

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Superseding ARP4767

Automatic Test Equipment, Relays Fully Rated 25 Amperes or Greater

RATIONALE

Five-Year Review and update of SAE ARP4767.

1. SCOPE

1.1 This SAE Aerospace Recommended Practice (ARP) is intended to be used as a guide for defining the methods to be used in performing electrical acceptance tests with automatic test equipment and to ensure repeatability and compatibility of results between manufacturers and between manufacturers and users.

1.2 It is understood that the terms relay and contactor are used interchangeably throughout this document.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1.1 U.S. Military Publications

Available from the Document Automation and Production Service (DAPS), Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, Tel: 215-697-6257, http://assist.daps.dla.mil/quicksearch/.

MIL-STD-202 Test Methods for Electronic and Electrical Component Parts

DOD-HBK-263 Electrostatic Discharge Control Handbook for Protection of Electrical and Electronic Parts

MIL-STD-704 Aircraft, Electric Power, Characteristics

MIL-STD-1000 Drawings Procurement (Identical Items), for Electronics Command Equipment

MIL-STD-1686 Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts

MIL-PRF-6106 Relays, Electromagnetic General Specification for

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: 724-776-4970 (outside USA)
Fax: 724-776-0790
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SAE WEB ADDRESS: **http://www.sae.org**

2.1.2 ANSI Publications

Available from American National Standards Institute, 25 West 43rd Street, New York, NY 10036-8002, Tel: 212-642-4900, www.ansi.org.

ANSI Z-540	Calibration Systems Requirements
ANSI Y 10.19	Letter Symbols for Units Used in Science and Technology
ANSI/IEEE STD 100	Standard Dictionary of Electrical and Electronic terms

2.1.3 ECA Publications

Available from ECA, 2500 Wilson Boulevard, Arlington, VA 22201, Tel: 703-907-8024, www.ec-central.org.

Engineer's Relay Handbook

2.2 Definitions

The definitions as stated in the Engineer's Relay Handbook shall apply unless otherwise stated herein.

3. PERFORMANCE REQUIREMENTS

3.1 It is the intent of this document to adequately define test equipment capable of performing the electrical tests of relays fully rated 25 A or more. These tests must be capable of performing without human assistance, except where specifically noted, and of recording the actual test results on electronic media and/or hard copy print out.

3.2 Pickup, Latch, and Reset Value (Voltage)

3.2.1 It is to be understood that pickup, latch, and reset are essentially the same function applied to different types of relays and contactors. Although the following discussion refers only to pickup, latch and reset value (voltage) will be verified and measured in the same manner.

3.2.2 Pickup value (voltage) shall be verified by instantaneously applying the maximum specified pickup value (voltage) to the pickup coil and observing that all contacts have transferred to the energized state. Failure of any contacts to transfer to the energized state shall result in relay rejection.

3.2.3 Pickup value (voltage) shall be measured after verification of pickup, by dropping out the relay by instantaneously removing coil voltage, reducing the coil voltage by 2% of the maximum specified pickup value (voltage), instantaneously reapplying to the pickup coil and observing that all contacts have transferred to the energized state. If proper operation occurs, the unit shall be dropped out, voltage reduced another 2% of the maximum specified pickup value (voltage), instantaneously reapplied, and checked for proper operation. This cycle shall be continued until the lowest applied voltage which fully operates he relay is determined. This lowest applied voltage shall be the measured pickup value (voltage). This technique shall be referred to as "step back".

3.2.4 A second method for measuring pickup value (voltage) is by step forward. In step forward, a voltage below the expected pickup value (voltage) is applied to the coil. This voltage as a default, will be the maximum permissible dropout value (voltage), but may be set to other values. From this initial value, the voltage to the coil shall be increased by steps of no more than 2% of the maximum specified pickup value (voltage), allowing sufficient time for relay response, until relay pickup occurs and all contacts have transferred to the energized state. The lowest voltage at which the relay picks up shall be the measured pickup value (voltage).

3.2.5 The third method for measuring pickup value (voltage) is by ramping. In ramping, a voltage below the expected pickup value (voltage) is applied to the coil. This voltage as a default, will be the maximum permissible dropout value (voltage), but may be set at other values. From this initial value, the voltage to the coil shall be increased in a linear manner, with a rise time of 10 times the L/R ratio of the tested coil. The lowest voltage at which the relay picks up and all contacts transfer to their energized state shall be the measured pickup value (voltage).

3.2.6 For both the step forward and ramp methods provided, the maximum pickup value (voltage) has been verified in accordance with 3.2.2. If pickup has not occurred by the time the maximum pickup value (voltage) has been reached, the test shall be terminated and the maximum pickup value (voltage) reported as the measured pickup value (voltage).

3.2.7 Higher rates of voltage ramping are permissible provided the ramp rate does not affect the integrity of the measurement by more than ±10%.

3.3 Dropout Value (Voltage) (Not applicable to latching devices)

3.3.1 The maximum operating voltage shall be applied to the coil and proper operation verified. The applied voltage shall be held for one time period and then reduced to zero within one to three time periods. The measured dropout value (voltage) is that voltage at which all the contacts have returned to their de-energized state. The measured dropout value (voltage) must be within the allowable dropout range. Failure to do so shall result in relay rejection.

3.3.2 Higher rates of voltage ramping are permissible provided the ramp rate does not affect the integrity of the measurement by more than ±10%.

3.4 Hold Value (Voltage) (Not applicable to latching devices)

3.4.1 The maximum operating value (voltage) shall be applied to the coil and proper operation verified. The applied voltage shall be held for one time period and then reduced to zero within one to three time periods. The measured hold value (voltage) is that voltage at which any contact changes from its energized state. Unless specifically stated otherwise, the specified hold value (voltage) shall be the maximum allowable dropout value (voltage). The relay shall be considered rejected if the measured hold value (voltage) is higher than the specified hold value (voltage).

3.5 Operating, Release, and Contact Bounce Times

3.5.1 An illustration defining operate, release, and contact bounce can be found in MIL-PRF-6106.

3.5.2 Unless otherwise specified, all times testing shall be performed at the rated coil voltage. When additional times tests are required, the ATE shall be capable of performing additional testing of any or all of the following requirements.

3.5.3 Auxiliary contact loading during testing shall be a maximum of 100 mA at 6 VDC, although it shall be possible to reduce the contact loading when specified. Primary contacts without a low level rating may have testing performed at any voltage up to the contact nominal rating. The timing mechanism shall be capable of resolving contact bounce 100 µs in duration on the auxiliary contacts.

3.5.4 The ATE shall be capable of measuring the operating, release, and bounce times of all contacts, comparing those times to a specified range of allowable values, and determining acceptance or rejection. The ATE shall also be capable of displaying the specific information on each contact.

3.5.5 It is understood that operate time refers to the time lapse between initial energization of the coil and the transfer of all contacts. As such, it is applicable to the pickup operation of side stable relays, and to latch and reset operation of latching relays. Contact bounce is not included in operate times. The appropriate voltage is to be instantaneously applied to the coil and the contacts monitored for operation. Any contact which exceeds the allowable limit shall be cause for relay rejection.

3.5.6 Release time refers to the time lapse between the removal of coil power and the transfer of all contacts. As such, it is applicable only to the dropout operation of sidestable and normally open relays. Contact bounce is not included in the measurement of release time. During testing, the coil voltage shall be instantaneously removed and the contacts monitored for proper operation. Any contact which exceeds the allowable limit shall be cause for relay rejection.

3.5.7 Contact bounce refers to that time period during pickup/closing and dropout/trip testing during which the contacts intermittently make and break continuity. The ATE shall be capable of distinguishing between contact bounce (contact voltage drop 90% or greater applied contact voltage) and dynamic contact resistance (contact voltage drop less than 90% of applied contact voltage). The ATE must be capable of looking for bounce at least four times longer than the maximum allowable bounce of the relay (i.e., 20 µs if the maximum is 5 µs). Coil voltage shall be instantaneously applied and removed during bounce testing. The ATE shall be capable of monitoring all contacts for both make and break bounce, measure the length of the contact bounce period and the number of bounces within that period and determine the acceptance or rejection of the relay. Any contact which exceeds the maximum allowable bounce shall be cause for relay rejection.

3.5.8 Unless make-before-break action is specified, double throw relays shall show no evidence of any normally open contacts closing before all normally closed contacts open; any normally closed contacts shall not make before all normally open contacts break. Contact break bounce on release of normally open contacts (where specified) shall be less than 100 µs.

3.6 Transfer Time

3.6.1 Transfer time is a test unique to double throw relays and refers to the time on a double throw contact during which no current flows through any of the contacts. Transfer times may be determined for sidestable or latching relays by calculation once the operate and release times are determined, or it may be tested. Transfer time during pickup will be the difference between the operate time of the normally closed contact of the double throw pair, and the operate time of the normally open contact of the double throw pair. Transfer time during dropout will be the difference between the release time of the normally open contact of the double throw pair, and the release time of the normally closed contact of the double throw pair. Transfer times shall be compared to the specified allowable transfer time. Unless otherwise specified, transfer time must be greater than zero and less than allowable limits. A transfer time for any contact outside of allowable range shall be cause for relay failure.

3.6.2 Transfer time of a center off, double throw relay is determined by energizing one coil and allowing sufficient time for all contacts to transfer their energized state, then instantaneously removing voltage from the energized coil, and reapplying it to the de-energized coil. The release time of all contacts of the first coil and the operate time of all contacts of the second, shall be measured, and the transfer time shall be calculated as the difference between the release time of the first coil energized - closed contacts and the operate time of the second coil energized - closed contacts for each double throw contact pair. Transfer time shall also be determined for the reverse sequence de-energizing the second coil, and energizing the first. The switching of coil power between the two coils must take no longer than 1 ms. The ATE shall be capable of performing transfer times testing at specified coil voltages, comparing the measured time with allowable limits, and rejecting the relay if the transfer time of any double throw contact exceeds allowable limits, or unless otherwise specified is zero.

3.7 Simultaneous Operation

3.7.1 Simultaneous operation is a requirement that certain groups of contacts operate together within a specified time period. Given the results of operate, release, and transfer time, simultaneous operation may be determined without additional testing, unless the coil voltage required for simultaneous operation is different than that used in operate, release, and transfer time tests. If additional testing is required, the ATE shall be capable of determining the needed test and calculating simultaneous operation from the results.

3.7.2 Relays with large numbers of auxiliary contacts may require the ATE to be capable of assigning all contacts into many groups. Within each group, the simultaneous operation range shall be the difference between the highest and lowest measured time within each group. Therefore, as many as ten simultaneous operation ranges may be obtained from each simultaneous test performed. The ATE shall be capable of comparing each measured value with the specified allowable range, and determining if the relay is acceptable or rejected. The ATE shall be capable of displaying the simultaneous operation range for each group, and if a relay is rejected, specify the average high and low for the group, and identify the specific high and low contact. Simultaneous operation may be required for operate, release, or transfer time. The ATE shall be capable of performing simultaneous operation on any, all, or none of the contacts.

3.8 Coil Current and Resistance

3.8.1 The ATE shall be capable of measuring the current flowing into each coil at a specified voltage. The current may be transitory, such as coil inrush lasting up to 200 ms, and steady state. The current that is reported shall be the maximum current measured during the reporting period. The ATE shall be capable of varying the coil voltage and measurement time, and compare the measured values for both inrush and steady state to maximum allowable values. Current in excess of allowable values shall be cause for relay rejection.

3.8.2 When required, coil resistance will be determined by repeating the pickup voltage test and dividing the voltage applied by the measured coil current. This may produce a pickup coil resistance and a hold coil resistance. The ATE shall be capable of determining the coil resistance without additional testing.

3.9 Coil Transient Suppression

3.9.1 When required, the ATE shall be capable of measuring the transient voltage generated by the relay coil during dropout, or during energizing of the second coil of a magnetically latched relay.

3.9.2 Transient voltage shall be measured as follows. The relay shall be energized by applying the maximum operating coil voltage of the proper polarity to the coil. After one to three time periods, the coil voltage shall be instantaneously removed and the relay allowed to dropout. The ATE shall be capable of measuring the peak negative voltage spike which follows and comparing it to the maximum allowable limit. An excessive voltage spike shall be cause for relay rejection. A transient voltage test when required shall be performed on each coil of the relay. It shall be possible to disable the reverse polarity check for selected relays.

3.10 Insulation Resistance

3.10.1 When required, the ATE shall measure the insulation resistance between all mutually insulated terminals and between all terminals and case in accordance with method 302, test condition B of MIL-STD-202. The test shall be performed in all possible states of the relay (a maximum of three).

3.10.2 The ATE shall accept a matrix describing the test points for each test state, and apply 500 VDC for a maximum of 2 min per test point. The resistance of that path shall be measured during the application of voltage, and if the resistance at any time during the 2 min period exceeds the minimum allowable insulation resistance and is increasing, the test may be terminated. The insulation resistance at the end of the test shall be the measured insulation resistance and be compared to the minimum allowable insulation resistance. Measured values below the allowable resistance shall be cause for relay failure.

3.10.3 The ATE shall allow insulation resistance to be measured at any point up to 2 min.

3.11 Dielectric Withstanding Voltage

3.11.1 Relays shall be tested in accordance with method 301 of MIL-STD-202. Dielectric voltage shall be applied between all mutually insulated parts and between these points and case or ground. A leakage current of more than 1.0 mA at the specified test voltage which is caused by arc over (air discharge), flash over (surface disclosure), breakdown (puncture discharge), or other insulation breakdown, shall constitute a relay failure.

3.11.2 The ATE shall accept a matrix describing the test points for each test state. This matrix is identical to that used in insulation resistance testing. Additionally, the ATE shall accept two test voltages for each test point, one describing a 1 min test, and one describing a 2 s test.

3.11.3 The ATE shall apply the 2 s voltage level for 2 s to each test point and test state as described by the supplied matrix. In the event of failure of any test point, the voltage level shall be reduced to the 1 min voltage level and applied to that test point only for 1 min. If that test point fails the 1 min test, it shall reject the relay. If the relay passes the reduced level, it shall be considered an acceptable relay, and proceed to the next test point, utilizing the 2 s voltage level for that test point.

3.12 Contact Voltage Drop

3.12.1 The ATE shall be capable of supplying the specified current at 6 VDC to the auxiliary contacts. The voltage drop shall be measured at the points to which external circuits are normally connected. The ATE shall be capable of applying the specified current to the main contact pair and adjusting as necessary for contact resistance. The relay shall then be cycled, and the contact voltage drop measured within 10 s. This cycle may be repeated with all readings taken on each specified contact pairs. If any individual reading is in excess of the allowable voltage drops, the relay shall be rejected.

4. ATE EQUIPMENT REQUIREMENTS

4.1 Control

4.1.1 The use of ATE is intended to reduce the labor associated with performing final testing of power relays and contactors. Accordingly, it is intended that a relay shall be attached to the ATE, and then fully tested, without further operator involvement, except in the event of relay failure.

4.1.2 The ATE shall be programmable with the ability to read its program from some form of permanent media.

4.1.3 The ATE shall be capable of displaying the status and results of testing on a screen to the operator, as well as printing out a hard copy identified by part number, serial number, work order number, lot number, date code, and date. It shall be possible to select the test results to be displayed or printed.

4.1.4 The ATE shall be capable of identifying relay failures, printing out the specific failure information and providing all possible information as to cause of the failure.

4.1.5 The ATE tests shall be modular in nature, and capable of being performed as stand alone tests, or in any desired sequence. Variations in test sequencing may be commanded by the operator.

4.1.6 Operator access to test sequencing shall be user friendly, and ideally through a menu system. Operators shall not be able to alter program requirements without proper authorization.

4.1.7 Programs for the ATE shall be capable of being prepared off line. If the required software is commercially available, it shall be specified in ATE documentation.

4.1.8 Software shall include computer aided verification capability if applicable, and calibration routines to allow exercising of all programmable subsystems.

4.2 Hardware

4.2.1 The ATE shall be capable of supplying 0 to 40 VDC, 10 A, with 0.01% regulation to each coil circuit and a maximum rise time of 100 µs.

4.2.2 The ATE shall be capable of supplying 0 to 115 VAC rms, 60 Hz, 2 A with 0.01% regulation to each coil circuit.